Autonomous Profilers for Carbon System and Biological Observations

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LONG-TERM GOALS

A major oceanographic problem is to understand the biogeochemical dynamics of the upper kilometer of the water column. Such an understanding is fundamental to the predictability of the processes partitioning carbon between atmosphere and ocean and of those redistributing carbon and associated elements within the water column. Key to predictability is understanding day-to-day variability of processes governing abundances of carbon species (dissolved and particulate, inorganic and organic) in the watercolumn.

OBJECTIVES

Our objective is to demonstrate the concept of low-cost autonomous profiling vehicles, outfitted with a suite of low-power optical, physical and chemical sensors, which when widely deployed, will permit high frequency - 4D -observations in the upper 1000 m of the variability of ocean biological processes, carbon biomass, upper ocean physics, and parameters of the carbon system. It is envisioned that once proven, such vehicles can be widely deployed to explore carbon biomass variability on global scales.

APPROACH

The autonomous platform to be used is the Sounding Oceanographic Lagrangian Observer (SOLO), a low-cost, low-power profiling float (Figure 1). This well proven ocean physics platform, augmented with new optical sensors for biogeochemistry, will permit the rapid and precise determination of two important products of photosynthesis, particulate organic carbon (POC) and particulate inorganic carbon (PIC), and physical data relevant to the understanding of the variability of these products.

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Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

Characteristics of SOLO

Height (incl antenna):	1.8 m
Weight in air: (trimmed for salt water)	23 kg
Maximum operating depth	1500 m
Available Energy:	4 MJ
Pressure resolution	1 decibar
Temperature	variable - to 0.005 C
Salinity accuracy	variable -to 0.01 psu
Life time: 6 yrs 120 cycles to 1500 m	

Figure 1. The Sounding Oceanograph Lagrangian Observer (SOLO). This lagrangian profiling float developed at Scripps has been widely deployed for ocean physics observations. Our work will demonstrate the value of this platform for integrated biogeochemical observations.

<u>POC</u>. Bishop (1999) and Bishop et al. (1999) have demonstrated that beam attenuation coefficient at 660 nm is strongly correlated with particulate organic carbon (POC) in open ocean waters (Figure 2).

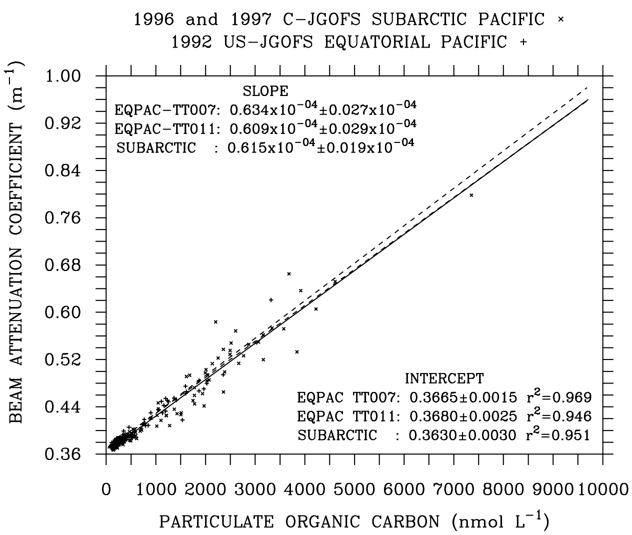

Figure 2. Comparison of POC determined from MULVFS samples vs. simultaneously measured beam attenuation coefficient, ***c***. The two dashed lines are the least sqares fit to data from two 2600 km NS transects at 140W in the equatorial Pacific. The solid line fits seasonal sampling along EW “line P” at 50N between the continental margin and ocean station PAPA (50N 145W).

Accurate and precise long-term high-frequency measurement of POC in the upper 1000 m requires the following: (1) a stable and precise transmissometer (beam attenuation stable to better than 0.001 m^{-1}), and (2) effective antifouling protection for transmissometer optics. This is work proposed by WETLabs.

PIC. Particulate inorganic carbon occurs mostly as the mineral calcite and in most locations calcite is the dominant mineral in suspension. For this reason, we are investigating optical properties (e.g. refractive index, birefringence...) specific to calcite. Scattering and transmission approaches to measure these specific properties will be investigated. Implementation will be a joint project of LBNL and WETLabs.

WORK COMPLETED

The partnership consists of personnel at LBNL, SIO, and WetLabs. Each has received separate funding. Since this is a partnership under the National Oceanographic Partnership Program (NOPP) and since funding for the project is less than one month old, we have chosen to submit a common report.

LBNL (in cooperation with WetLabs, Inc.) has initiated work on the design and implemention of sensors for particulate organic carbon (POC) and particulate inorganic carbon (PIC) on SOLO. For POC, WetLabs is beginning to address (1) and (2) above. For PIC, we have begun work with Dr. Arlon Hunt (LBNL) to investigate the Mueller matrix properties of calcite suspensions. To date, we have gained familiarity with Dr Hunt's aparatus using suspensions of marine calcite. The plan is to contrast results with sediments high in other inorganic (e.g. clays and diatomaceous opal) phases. The work is being carried out by Christopher Guay at LBNL, who is also supported by the NOAA Climate and Global Change Postdoctoral Fellowship program.

WetLabs has estabished links with both SIO and LBNL and is beginning work on implementation of the POC sensor. They are awaiting input from LBNL on how to proceed with implementing a PIC sensor.

SIO: The basic instrument that will support new bio-optical sensors will be the SOLO float that has been in routine service at SIO for three years (Figure 1). SIO is exploring alternative SOLO CPU systems to accommodate multiple sensors (both analog and serial devices) as well as GPS and Orbcomm satellite communication signals. This new CPU/controller will provide the computational power and flexibility to allow integration of a broad spectrum of physical-optical-chemical sensors, yet be low enough power for long-term deployments. Parts for three SOLO platforms have been ordered.

SIO is delaying selection of a conductivity sensor while three are tested under separate funding. Discussions have begun with WetLabs Inc. regarding the electrical and mechanical specifications of the transmissometers to be integrated into the package for the first field tests in July 2000. An emergency drop weight used in the underwater glider Spray is also being modified for use on the SOLO float to protect valuable new bio-optical instruments.

RESULTS

There are no project results yet due to the short duration of support for this new project.

IMPACT/APPLICATIONS

The sensors and methodology employed in this project can easily migrate to other autonomous platforms; furthermore, the work of this partnership will lay the foundation for expanded sensor suites and their integration onto recoverable autonomous self-navigating platforms designed to quantify both the reactants and products of photosynthesis, and the rates of carbon-system processes.

TRANSITIONS

None at this time.

RELATED PROJECTS

Russ Davis and Jeff Sherman (SIO) and Casey Moore (WETLabs) are supported separately by ONR under this NOPP project.

Greg Mitchell and Jeff Sherman (SIO) are supported through the ocean optics program to instrument SOLO with radiance sensors. If proven, such sensors would be desirable to integrate with the POC, and PIC sensor suite planned for the SOLO-E.

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